Improved method of reducing blocking artifacts

FIELD OF THE INVENTION

The invention relates to a method of processing an input signal, said input signal comprising blocks and said blocks comprising n-bits binary input samples, with n being an integer.

The invention is particularly relevant for the post-processing of video signals which have been encoded using a block-based compression method, such as, for example, the one described in MPEG-2, MPEG-4, H.261 or H.263 standards, and may be used in order to reduce blocking artifacts caused by the compression.

BACKGROUND ART

The United States patent US 4,941,043 gives a method of reducing blocking artifacts in a video signal. A transmit side encoder transmits frequency limitation parameters allocated to the individual blocks of the video signal. The frequency limitation parameters are used at the receive-side decoder to control a block filter function at the output of the decoder that outputs a decoded video signal, controlling this for post-processing of the decoded video signal for the purpose of reducing the blocking artifacts. The proposed method is based on the fact that disturbing effects are dependent on the degree of frequency limitations applied at the level of the encoder. Moreover, this proposed method is rather complex and requires parameters from the encoder, which might not always be available.

SUMMARY OF THE INVENTION

It is an object of the invention to provide a simple and efficient method of processing a digital signal for reducing blocking artifacts, without an a priori knowledge of the encoding parameters of the input signal.

To this end, a method of processing such as described in the opening paragraph comprises at least :

– a low pass filtering step applied to the input signal, which results in a filtered signal comprising filtered samples,

– a determination step for determining a correction area around block boundaries,

–   a correction step for adding a random binary number, comprising at least one bit, to the
filtered samples belonging to the correction area, which results in an output signal.

        Said method of processing is especially efficient in uniform areas of medium
contrast and low temporal activity, where a block edge difference of luminance or
chrominance equal to 1 for a luminance value L0, is visible to the human eye. This fact is
illustrated in Fig. 1, which shows the evolution of the visibility threshold VT as a function of
the luminance signal L under certain conditions of contrast, spatial activity and temporal
activity. The visibility threshold and the luminance signal values are comprised between 0
and 255 in this example and L0 is around 50.

        As a consequence, the method of processing according to the invention allows
the visibility of blocking artifacts to be reduced in all cases by filtering at block boundaries.
Moreover, this method of processing also allows the visibility of blocking artifacts to be
reduced in uniform areas when the block edge difference is minimal, by adding random noise
around the block boundary, in which particular case the usual processing methods based on
low pass filtering are inefficient.

        The present invention also relates to a computer program product for a
receiver, such as a television set or a set-top-box, which product comprises a set of
instructions, which, when loaded into the receiver causes the receiver to carry out the
previously described method of processing.

        These and other aspects of the invention will be apparent from and will be
elucidated with reference to the embodiments described hereinafter.

BRIEF DESCRIPTION OF THE DRAWINGS

        The invention will now be described in more detail, by way of example, with
reference to the accompanying drawings, in which :

        Fig. 1 shows the variation of the visibility threshold as a function of the
luminance signal in certain conditions of contrast, spatial activity and temporal activity,

        Fig. 2 shows a block diagram of a method in accordance with the invention,

        Fig. 3a illustrates a block boundary in a uniform area with a block edge
difference of 1,

        Fig. 3b illustrates the result of a step of multiplying the input samples by 4
according to the invention,

        Fig. 3c illustrates the result of a filtering step according to the invention,

Fig. 3d illustrates the result of a step of determining a correction area according to the invention, and

Fig. 3e illustrates the result of a correction step according to the invention.

5   DETAILED DESCRIPTION OF THE INVENTION

A method of processing according to the invention is depicted in Fig. 2. Such a method of processing comprises at least :

– a low pass filtering step (FIL) applied to the input signal (IS), which results in a filtered signal (FS) comprising filtered samples,

10   – a determination step (DET) for determining a correction area (CA) around block boundaries,

– a correction step (COR) for adding a random binary number (RN) comprising at least one bit to the filtered samples belonging to the correction area, which results in an output signal (OS).

15   In the preferred embodiment, the input signal is a MPEG-2 video signal, which has been encoded and decoded using 8x8 blocks, said blocks comprising n-bit binary input samples, with n being an integer. The input samples are, for example, the luminance or the chrominance samples or both of them. It will be apparent to a person skilled in the art that the method of processing is intended to be used for any signal that has been encoded and

20   decoded using a block-based processing.

The method of processing according to the invention comprises five main steps, which are illustrated by Fig. 3a to Fig. 3e.

Fig. 3a shows a row or a column of two adjacent blocks p and p+1 in a

25   uniform area with a block edge difference of 1. The input samples are represented by black dots, the values of the input samples belonging to the block p being equal to L and the values of the input samples belonging to the block p+1 being equal to L+1, with p and L being integers.

Fig. 3b shows a multiplication of the input samples by a power of 2, which

30   results in a modified signal comprising modified samples of m-bit binary numbers. In the preferred embodiment, the power of 2 is 4 and, as a consequence, m is equal to n+2.

Fig. 3c illustrates the filtering of the modified signal around the block boundaries. The filter used is a low pass filter. If such a filter was applied directly to the input signal, the filtering would be of no use in the case of a block edge difference of 1. Depending

on the filter characteristics, the values of some modified samples are changed. The filtered samples are here represented as circles.

Fig. 3d shows the determination of a correction area, which consists in the computing of mask values associated with the input samples and equal to the 2 least

5   significant bits of the filtered samples. In the present example, the mask values MV are the following :

−   if FS[i][j] = 4L   then   MV = 4L%4 = 0,
−   if FS[i][j] = 4L+1   then   MV = (4L+1)%4 = 1,
−   if FS[i][j] = 4L+2   then   MV = (4L+2)%4 = 2,
10   −   if FS[i][j] = 4L+3   then   MV = (4L+3)%4 = 3,
−   if FS[i][j] = 4L+4   then   MV = (4L+4)%4 = 0,
                where : -   i, j are integers such as i=0 to 7 and j=0 to 7,
                              -          % is the operation such as a%b gives the remainder of the
division of a by b.

15   In the preferred embodiment, the correction area (CA) corresponds to the area where the mask values are different from zero.

In another embodiment, the correction area can be determined arbitrarily as being equal, for example, to 4 pixels : 2 pixels on each side of the block boundary. With such an embodiment, the multiplication of the input samples by a power of 2 and the division of

20   the filtered samples by said power of 2 are no longer required but the method of processing is less flexible.

Fig. 3e shows the output signal which, when the mask values are different from zero, results from an addition of a random binary number to the filtered samples divided by 4. In the preferred embodiment, the random binary number is 0 or 1 and is generated by a

25   random number generator.

The method of processing in accordance with the invention is applied in the horizontal direction and in the vertical direction, the horizontal and vertical processing being similar and being applied successively in any order. Such a method of processing is

30   implemented in an integrated circuit, which is intended to be integrated, for example, in a set-top-box or in a television receiver.

The method of processing in accordance with the invention can be implemented in an integrated circuit, which is intended to be integrated into a set top box or a

television receiver. A set of instructions that is loaded into a program memory causes the integrated circuit to carry out said processing method. The set of instructions may be stored on a data carrier such as, for example, a disk. The set of instructions can be read from the data carrier so as to load it into the program memory of the integrated circuit which will then

5   fulfil its role.

It will be obvious that the use of the verb "to comprise" and its conjugations does not exclude the presence of any other steps or elements besides those defined in any claim.